Design value	
calculated	

## Parameter   Units   Tolerance    1.1 Project Management   Units   Tolerance    General PHYSICS Requirements, Upsilons    Paradospality coverage, jetal   4   11   1   1   1   1   1   1   1		calculated			
Command PHYSICS Requirements, Upsilons   Service   Command   Com	Parameter		Units	Tolerance	Notes
Command PHYSICS Requirements, Upsilons   Service   Command   Com	1.1 Project Management				
Secretary PHYSICS Requirements, Upsilons   Security Physics to separate the three states of the Y family.   Security Physics to separate the three states of the Y family.   Security Physics to separate the three states of the Y family.   Security Physics Physi	, ,				to get high enpough statistics in p+p, p+A and A+A data
Secretary PHYSICS Requirements, Upsilons   Secretary					
Pseudorage (160a)	General PHYSICS Requirements Unsilons				
Assumutation coverage   360   deg     full 2x coverage		c 111		(rango)	sufficient to separate the three states of the Frankly.
more tracker radius   \$80	. , . , , ,			(range)	full 2π coverage
Data acquisition rate Trigger efficiency 90 % min for electrons from y > 0 e in pry pand ptA Track reconstruction efficiency 90 % min for p > 3 eV/c Track reconstruction purity 90 % min for p > 3 eV/c Momentum resolution 1.2 % non for p : 1 feet range 4.10 GeV/c Momentum resolution 1.2 % non for p : 1 feet range 4.10 GeV/c Momentum resolution 1.2 % non for p : 1 feet range 4.10 GeV/c Trigger efficiency  General PHYSICS Requirements, jets General PHYSICS Requirements, min consistency resolution 1.2 150 %/VIE.gl - max 1 in pr for R = 0.2 -0.4 lets increase resolution 1.2 - max in pr for R = 0.2 -0.4 lets increase resolution 1.3 % max 1 in pr for R = 0.2 -0.4 lets increase of jet sizes with high statistics and performance insensitive to the details of jet fragmentation increase resolution 1 max in pr for R = 0.2 -0.4 lets including effect of underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is its statu an afactor of 3 or not underlying event such that scale of unfolding on raw yelds is status and afactor of 3 or not status and an afactor of 3 or not underlying event s				may	Tuli 2/1 Coverage
Trigger efficiency   90   % min   for electrons from y > e*e* in p+p and p+A   Track reconstruction efficiency   90   % min   for p+3 deV/c   Track reconstruction purity   90   % min   for p+3 deV/c   Track reconstruction purity   90   % min   for p+3 deV/c   Track reconstruction purity   90   % min   for p+3 deV/c   Track reconstruction purity   90   % min   for p+3 deV/c   Track reconstruction purity   90   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction   70   % min   for p+3 deV/c   Track reconstruction   70   % min   for p+3 deV/c   Track reconstruction   70   % min   for p+3 deV/c   Track reconstruction purity   70   % min   for p+3 deV/c   Track reconstruction   70   % min					
Track reconstruction efficiency 90 % min for p3 3 GeV/C moments of properation					for electrons from v-> e <sup>+</sup> e <sup>-</sup> in n+n and n+A
Track reconstruction purity  12		+			
Momentum resolution   1.2   5%   nom   for p. in the range 4-10 GeV/c			-		• • • • • • • • • • • • • • • • • • • •
Figure 2011   Figure 2012   Figure 2013					• • • • • • • • • • • • • • • • • • • •
General PHYSICS Requirements, jets  General PHYSICS Requirements, jets  General PHYSICS Requirements, jets  For expressibilition  1			-		
Containment of popusing jet axis   Sequirements, dijets   Containment of popusing jet axis   Sequirements, dijets   Containment of popusing jet axis   Sequirements, dijets   Containment of pape in the performance in containment of pape in the performance in	Electron identification eniciency	70	%	min	
General PHYSICS Requirements, jets corporation    - 120 Sk/HE <sub>p</sub>   - max					
Seergy resolution					range of jet sizes with high statistics and performance
Series	General PHYSICS Requirements, jets				insensitive to the details of jet fragmentation
Integry resolution  Integ	Energy resolution	< 120 %/V(E <sub>iet</sub> )	-	max	in p+p for R = 0.2 -0.4 jets
Energy resolution	Energy resolution	< 150 %/V(E <sub>iet</sub> )	-	max	in central Au+Au for R = 0.2 jets
Fenergy resolution		, jeu			including effect of underlying event such that scale of unfolding on
See the sear remember is   3	Energy resolution	-	-	-	
Jet measurement, R		3	%	max	for inclusive jets
Energy measurement   insensitive     to softness of fragmentation (quarks or gluons HCal + EMCal   Elettrager capability   without jet bias   -     to achieve large acceptance in conjunction with the general PHYSICS Requirements, dijets   So.   So.   So.   Min   General PHYSICS Requirements, dijets   So.   So.   So.   Min   Full containment of opposing jet axis   So.   So.   So.   Min   Full containment   70   %   Min   for R = 0.2 dijets   Systematic uncertainty   10   %   Max   for R_wand A <sub>1</sub> as measured (also key in p+A, onset of effects)   General PHYSICS Requirements, fragmentation functions   Tracking resolution limit   do.   GeV/c   Min   (do/o < 0.2% x.p)   General PHYSICS Requirements, heavy quark jets   Gev/c   Min   (do/o < 0.2% x.p)   General PHYSICS Requirements, high containment   Gev/c   Min   Gev/c   Min   Gev/c   Min   General PHYSICS Requirements, direct photon   100   Microns   Max   For electron p <sub>1</sub> > 4 GeV/c   Min   Gev/c   Min   General PHYSICS Requirements, direct photon   15   %/V(E)   Min	Jet measurement, R	0.20	-	Minimum	segmentation no coarser than Δη x Δφ ~0.1 x 0.1
Selection   Sele	Underlying event influence event-by-event	ATLAS method	-	1	large coverage HCal/EMCal)
Rejection 95.00 % min of high p-rharged track backgrounds (HCall)  General PHYSICS Requirements, dijets  Containment of opposing jet axis  Full containment  Systematic uncertainty  General PHYSICS Requirements, fragmentation functions  Tracking resolution limit  Independent measurement of pand E  General PHYSICS Requirements, heavy quark jets  DCA precision  General PHYSICS Requirements, heavy quark jets  DCA precision  Electron identification for high for p->  4 GeV/c  Min  General PHYSICS Requirements, direct photon  Electron identification for high for p->  4 GeV/c  Min  General PHYSICS Requirements, direct photon  EMCal segmentation \( \text{in} \) \( \text{in} \) \( \text{in} \)  General PHYSICS Requirements, high statistics  Tracking resolution for photon ID  EMCal cluster trigger  General PHYSICS Requirements, high statistics  Tracking resolution for photon ID  Tracking r	Energy measurement	insensitive	-	-	to softness of fragmentation (quarks or gluons HCal + EMCal
Containment of opposing jet axis  Bo We min for R = 0.2 dijets  Systematic uncertainty  10 % max  General PHYSICS Requirements, fragmentation functions  Tracking resolution limit Independent measurement of p and E  General PHYSICS Requirements, heavy quark jets  General PHYSICS Requirements, heavy quark jets  DA precision  Electron identification for high for pt, > 4 GeV/c  In min  General PHYSICS Requirements, direct photon  EMCal segmentation for high for pt, > 4 GeV/c  In min  General PHYSICS Requirements, heavy quark jets  DCA precision  Electron identification for high for pt, > 4 GeV/c  In min  General PHYSICS Requirements, direct photon  EMCal segmentation for high for pt, > 4 GeV/c  In min  EMCal cluster trigger  General PHYSICS Requirements, high statistics  Data acquisition rate  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (\(\text{D}\text{P}\text{P}\))  Note: BABAR magnet acquired magnitude of tracking system capability at 10 GeV/c (order of magnitude)  Momentum resolution (\(\text{D}\text{P}\text{P}\text{S}\text{P}\)  Momentum resolution (\(\text{D}\text{P}\text{P}\text{S}\text{P}\text{S}\text{P}\text{PHYSICS Requirements}  Momentum resolution (\(\text{D}\text{P}\text{P}\text{P}\text{S}\text{P}\text{PL}\text{ and magnitude}  Momentum resolution (\(\text{D}\text{P}\text		without jet bias	-	-	
Seneral PHYSICS Requirements, dijets   Seneral requirements for jets, as above	Rejection	95.00	%	min	of high p <sub>⊤</sub> charged track backgrounds (HCal)
Seneral PHYSICS Requirements, dijets   Seneral requirements for jets, as above					
Solution					to achieve large acceptance in conjunction with the
Full containment Systematic uncertainty  General PHYSICS Requirements, fragmentation functions  Tracking resolution limit  A0 GeV/c Independent measurement of p and E Capable  General PHYSICS Requirements, heavy quark jets  DCA precision Electron identification for high for p <sub>7</sub> >  General PHYSICS Requirements, direct photon  EMCal segmentation day x Aф Gev/c  General PHYSICS Requirements, high statistics  General PHYSICS Requirements, high statistics  Data acquisition rate  Magnet PHYSICS Requirements  Momentum resolution (\(\frac{Ap}{P}\))  Alignment A and A, as measured (also key in p+A, onset of effects)  for unbiased measurement of jet energy acceptance  for unbiased measurement of jet energy acceptance  for unbiased measurement of jet energy acceptance  for identifying photons  for identifying photons  for identifying photons  EMCal resolution for photon ID  15  %//(E) min  Capable    nom	General PHYSICS Requirements, dijets				general requirements for jets, as above
Systematic uncertainty    10	Containment of opposing jet axis	80	%	min	
General PHYSICS Requirements, fragmentation functions  Tracking resolution limit  40 GeV/c min (dp/p < 0.2% x p) Independent measurement of p and E  capable  - (z=p/E)  General PHYSICS Requirements, heavy quark jets  DCA precision  Electron identification for high for p₁> 4 GeV/c min  General PHYSICS Requirements, direct photon  EMCal segmentation Δη x Δφ  EMCal resolution for photon ID  EMCal cluster trigger  General PHYSICS Requirements, high statistics  DA precision  EMCal segmentation Δη x Δφ  General PHYSICS Requirements, direct photon  EMCal resolution for photon ID  15 %/V/E) min  EMCal cluster trigger  General PHYSICS Requirements, high statistics  The photon  Data acquisition rate  15 kHz  nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (Δp/p)  Azimuthal coverage  360 deg  - for unbiased measurement of jet energy acceptance  for electron p₁> 4 GeV/c  min  for identifying photons  for identifying photons  For identifying photons  ability to sample high statistics for p+p. p+A, A+A at all centralities requires high rate, high throughput DAQ  magnet and tracking system capability at 10 GeV/c (order of magnitude)  Momentum resolution (Δp/p)  Azimuthal coverage  360 deg  - full 2π coverage  The photon in the photon in the picture of the photon in the photon	Full containment	70	%	min	for R = 0.2 dijets
fragmentation functions         for unbiased measurement of jet energy acceptance           Tracking resolution limit independent measurement of p and E         40         GeV/c         min         (dp/p < 0.2% x p)	Systematic uncertainty	10	%	max	for R <sub>AA</sub> and A <sub>J</sub> as measured (also key in p+A, onset of effects)
fragmentation functions         for unbiased measurement of jet energy acceptance           Tracking resolution limit independent measurement of p and E         40         GeV/c         min         (dp/p < 0.2% x p)					
Tracking resolution limit  40 GeV/c min (dp/p < 0.2% x p) Independent measurement of p and E capable - (z=p/E)  General PHYSICS Requirements, heavy quark jets  DCA precision Electron identification for high for p₁ > 4 GeV/c min  General PHYSICS Requirements, direct photon  EMCal segmentation Δη x Δφ 0.024 x 0.024 - nom EMCal resolution for photon ID 15 %/V(E) min  EMCal cluster trigger capable in p+p and p+A at with rejections > 100 GeV  General PHYSICS Requirements, high statistics  Data acquisition rate 15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (Δp/p) 1.0 % nom agent and tracking system capability at 10 GeV/c (order of magnitude)  Azimuthal coverage 360 deg - full 2π coverage  Central field 1.5 T approx measurements to correct for nonuniformities, especially close to the	General PHYSICS Requirements,				
Independent measurement of p and E   Capable   - Ca	fragmentation functions				for unbiased measurement of jet energy acceptance
Independent measurement of p and E   Capable   - Ca		40	GeV/c	min	, ,
Quark jets   DCA precision   100 microns   max   for electron p <sub>T</sub> > 4 GeV/c   min		capable	-	-	
Quark jets   DCA precision   100 microns   max   for electron p <sub>T</sub> > 4 GeV/c   min					
DCA precision   100   microns   max   for electron p <sub>T</sub> > 4 GeV/c   min	General PHYSICS Requirements, heavy				
DCA precision   100   microns   max   for electron p <sub>T</sub> > 4 GeV/c   min	quark jets				for unbiased measurement of jet energy acceptance
Electron identification for high for p <sub>T</sub> > 4 GeV/c min  General PHYSICS Requirements, direct photon  EMCal segmentation Δη x Δφ 0.024 x 0.024 - nom EMCal resolution for photon ID 15 %/V(E) min  EMCal cluster trigger capable in p+p and p+A at with rejections > 100 for E <sub>V</sub> > 10 GeV  General PHYSICS Requirements, high statistics capable statistics for p+p. p+A, A+A at all capable statistics requires high rate, high throughput DAQ statistics requires hig	<u> </u>	100	microns	max	
General PHYSICS Requirements, direct photon	·				Tot electron pt > 4 de v/e
Photon   Photon   For identifying photons	Liectron identification for high for $\mu_T$ ?	4	GeV/C	111111	
Photon   Photon   For identifying photons	Ganaral DHVSICS Paguiroments direct				
EMCal segmentation Δη x Δφ					f:
EMCal resolution for photon ID  EMCal cluster trigger  capable  in p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV  General PHYSICS Requirements, high statistics  Data acquisition rate  15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (Δp/p)  Azimuthal coverage  Azimuthal coverage  Sequirements  1.0 % nom magnitude)  Azimuthal coverage  360 deg - full 2π coverage  Pseudorapidity coverage, η (eta)  Central field  1.5 T approx  Inner radius  Min p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV  in p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV  in p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV  in p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV  ability to sample high statistics for p+p. p+A, A+A at all centralities requires high rate, high throughput DAQ  Note: BABAR magnet acquired  magnet and tracking system capability at 10 GeV/c (order of magnitude)  full 2π coverage  Central field  1.5 T approx  Inner radius  measurements to correct for nonuniformities, especially close to the	·				for identifying photons
EMCal cluster trigger  General PHYSICS Requirements, high statistics  General PHYSICS Requirements, high statistics  Data acquisition rate  15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (Δp/p)  Azimuthal coverage  Pseudorapidity coverage  Pseudorapidity coverage, η (eta)  Central field  1.5 T approx  Inner radius  In p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV  ability to sample high statistics for p+p. p+A, A+A at all central fiele stat			-		
General PHYSICS Requirements, high statistics by ability to sample high statistics for p+p. p+A, A+A at all centralities requires high rate, high throughput DAQ  Data acquisition rate 15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements Note: BABAR magnet acquired magnet and tracking system capability at 10 GeV/c (order of magnitude)  Azimuthal coverage 360 deg - full 2π coverage  Pseudorapidity coverage, η (eta) ≤  1.1  - (range)  Central field 1.5 T approx Inner radius measurements to correct for nonuniformities, especially close to the				min	
Statistics  Data acquisition rate  15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (Δρ/ρ)  Azimuthal coverage Pseudorapidity coverage, η (eta)  Central field Inner radius  Central field  C	EMCal cluster trigger	capable	-	-	in p+p and p+A at with rejections > 100 for E <sub>γ</sub> > 10 GeV
Statistics  Data acquisition rate  15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Momentum resolution (Δρ/ρ)  Azimuthal coverage Pseudorapidity coverage, η (eta)  Central field Inner radius  Central field  C	Conoral DUVCICC Description				ability to compale high statistics for some A. A. A. A. I. II
Data acquisition rate  15 kHz nom  1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Note: BABAR magnet acquired  magnet and tracking system capability at 10 GeV/c (order of magnitude)  Azimuthal coverage  Seudorapidity coverage, η (eta)  Central field  1.5 T approx  Inner radius  15 kHz nom  Note: BABAR magnet acquired  magnet and tracking system capability at 10 GeV/c (order of magnitude)  full 2π coverage  full 2π coverage  approx  measurements to correct for nonuniformities, especially close to the					
1.2 Superconducting Magnet  Magnet PHYSICS Requirements  Note: BABAR magnet acquired  magnet and tracking system capability at 10 GeV/c (order of magnitude)  Azimuthal coverage  Pseudorapidity coverage, η (eta)  Central field  1.5  T approx  Inner radius  Note: BABAR magnet acquired  magnet and tracking system capability at 10 GeV/c (order of magnitude)  full 2π coverage  full 2π coverage  approx  measurements to correct for nonuniformities, especially close to the	statistics				centralities requires high rate, high throughput DAQ
Magnet PHYSICS Requirements       Note: BABAR magnet acquired         Momentum resolution (Δp/p)       1.0       %       nom       magnet and tracking system capability at 10 GeV/c (order of magnitude)         Azimuthal coverage       360       deg       -       full 2π coverage         Pseudorapidity coverage, η (eta)       ≤   1.1         -       (range)         Central field       1.5       T       approx         Inner radius       140       cm       approx         measurements to correct for nonuniformities, especially close to the	Data acquisition rate	15	kHz	nom	
Magnet PHYSICS Requirements       Note: BABAR magnet acquired         Momentum resolution (Δp/p)       1.0       %       nom       magnet and tracking system capability at 10 GeV/c (order of magnitude)         Azimuthal coverage       360       deg       -       full 2π coverage         Pseudorapidity coverage, η (eta)       ≤   1.1         -       (range)         Central field       1.5       T       approx         Inner radius       140       cm       approx         measurements to correct for nonuniformities, especially close to the					
Magnet PHYSICS Requirements       Note: BABAR magnet acquired         Momentum resolution (Δp/p)       1.0       %       nom       magnet and tracking system capability at 10 GeV/c (order of magnitude)         Azimuthal coverage       360       deg       -       full 2π coverage         Pseudorapidity coverage, η (eta)       ≤   1.1         -       (range)         Central field       1.5       T       approx         Inner radius       140       cm       approx         measurements to correct for nonuniformities, especially close to the	1.2 Superconducting Magnet				
Momentum resolution (Δp/p)  Azimuthal coverage  Pseudorapidity coverage, η (eta)  Central field  Inner radius  Momentum resolution (Δp/p)  1.0  %  nom  magnitude)  full 2π coverage  full 2π coverage  (range)  (range)  T  approx  measurements to correct for nonuniformities, especially close to the	·				Note: BABAR magnet acquired
Momentum resolution (Δρ/p)     1.0     %     nom     magnitude)       Azimuthal coverage     360     deg     -     full 2π coverage       Pseudorapidity coverage, η (eta)     ≤ 1.1      -     (range)       Central field     1.5     T     approx       Inner radius     140     cm     approx       measurements to correct for nonuniformities, especially close to the					
Azimuthal coverage     360     deg     -     full 2π coverage       Pseudorapidity coverage, η (eta)     ≤  1.1      -     (range)       Central field     1.5     T     approx       Inner radius     140     cm     approx       measurements to correct for nonuniformities, especially close to the	Momentum resolution (An/n)	1.0	%	nom	
Pseudorapidity coverage, η (eta) ≤ 1.1  - (range)  Central field 1.5 T approx  Inner radius 140 cm approx  measurements to correct for nonuniformities, especially close to the	, , , , ,			-	<u> </u>
Central field 1.5 T approx Inner radius 140 cm approx measurements to correct for nonuniformities, especially close to the			<del>                                     </del>	(range)	
Inner radius 140 cm approx measurements to correct for nonuniformities, especially close to the		<del> </del>			
measurements to correct for nonuniformities, especially close to the					
Field measurement accuracy 1 % max plug doors					measurements to correct for nonuniformities, especially close to the
	Field measurement accuracy	1	%	max	plug doors

Design value
calculated

Parameter		Units	Tolerance	Notes
Magnet Mechanical				
				Rutherford-type superconducting cable co extruded with an outer
Conductor material (magnet coil)	niobium titanium	-	-	aluminum matrix
Cable construction: number of strands	16.0	-	-	
Strand diameter	0.8	mm	nom	
Copper to superconductor ratio Filament size	1:1	-	-	
Twist pitch	40.0 25.0	μm	max	
Cable shape	rectangular	μm -	nom -	
Cable sitape  Cable size	1.4 x 6.4	mm x mm	nom	
Aluminum matrix size, body	8.49 x 20	mm x mm	nom	
Aluminum matrix size, ends	4.93 x 20	mm x mm	nom	
Coil offset with respect to outer cryostat	30.0	mm	nom	axial offset towards the lead-in end
. ,				
Solenoid Inner Radius	142.0	cm		Measured within this tolerance by BNL survey
Solenoid Outer Radius	177.0	cm	· ·	Measured within this tolerance by BNL survey
Solenoid length	384.88	cm	+/04	The Asia of Case BADAD (City and Case)
Solenoid estimated weight	30865.00	lbs	est	without stack, fom BABAR lifting analyses
Stack weight	3000.00 3512.00	lbs	est +/- 0.2	rough estimate
Coil length coil radial width	40.80	mm mm		measured as built (3513 from BABAR paper) from BABAR paper
Coil radius (at mid width)	1530.20	mm	spec	from BABAR paper
Relief valve, crack pressure rating	1530.20	111111	spec	HOHI BABAK Papel
Burst Disk design pressure rating				
Burst Bisk design pressure ruting				**For other dimensions consult the sPHENIX magnet website at:
				https://collab.external.bnl.gov/sites/sPHENIX-
				Magnet/SitePages/Parameters.aspx
Magnet Electrical				
Solenoid main coil current	4596.00	Amps	max	from BABAR paper
Solenoid current density (main coil)	1.20	kA/sq mm	calc	(outer coil, 1/2 this on the central coil) from BABAR paper
Solenoid Inductance	2.57	Н	spec	from BABAR paper
Coil Stored energy	27.0	MJ	spec	from BABAR paper
Critical current	12,680	Amps	max	
Current safety margin	2.5	-	-	
Dump resistor	68.00	mΩ		used to quickly reduce current in the event of quench
Ground current resistor	67.00	mΩ		limits ground current should coil fault
Cable resistance	1.25	mΩ		SLAC configuration
Voltage across magnet	6.25 92.00	V A		
Curren through dump resister Peak power supply voltage	12.10	V		
# of voltage taps	12.10	· ·		
# of LVDT's				
# of strain gages	28	-	-	counted
Service building compressor	150.00	kW	nom	480 VAC
Coldbox and magnet valvebox	6.00	kW	nom	120 VAC
Magnet Magnetic				
Central Field	1.5	Tesla	nom	magnet calculations indicate 1.4 T in sPHENIX config.
Time to reach full field	30.70	minutes		@ 2.5 A/sec ramp rate
Tme constant, slow discharge	33.30	minutes		slow discharge through freewheeling diode and cable resistance
Time to decay fom 4.6 kA to 100 A, slow discharge	2.10	hours		
Tme constant, fast discharge through dump				
resistor	36.76	seconds		slow discharge through freewheeling diode and cable resistance
Time to decay fom 4.6 kA to 100 A, fast discharge		l .		
through dump resistor	2.34	minutes		
Number of inner windings	536			
Number of outer windings	531			
NA- 10				
Magnet Cryogenic	1	1	1	
Operating Temp	4.50	K	max	
Cryogen				
· -	LHe	-	-	
Cold mass heat load (operating temp) Outer heat shield temperature	70 40	W K	est nom	cooled by cold mass boil off

	Design value calculated			
Parameter	carculated	Units	Tolerance	Notes
Outer heat shield heat load	110	W	est	
Transfer line, dewar and bayonet losses	14	w	est	114 W if plant is located in service building
Flow Rate, leads	0.2	g/s	nom	
Flow Rate, shield	0.35	g/s	nom	
Inlet Pressure				
Pressure Drop				
Storage dewar capacity	300.00	liter	nom	Required to allow liquid draw of 5 g/s and vapor generation of 1 g/s to allow rampdown of the magnet within 1 hr
Compressor dimensions	2.3x2.0x2.0 H	m x m x m	nom	(if self-contained helium supply system is selected)
Coldbox rating	325-400	W		
Local Gas Storage	6000.00	gal		@ 13 bar to allow summer shutdown testing
Cooling Water	50.00	gpm		@20psid 50/50 water for cryogenic expanders work extraction heat
Conditioned water	4.00	Inm		exchangers
Instrument air	8.00	lpm scfm		@-40C, 80 psig
inisti unient an	8.00	301111		to be supplied from existing PHENIX LN2 dewar; new LN2 transfer
Liquid nitrogen				line needed
				Note: parameters other than PHYSICS Requirements broken into 4
1.3 Tracker				subsections: (1) Re-Use Inner PIXELS, (2) new INNER MAPS PIXELS, (3) Silicon Strip Outer Tracker and (4) TPC Chamber Outer Tracker
Tracker PHYSICS Requirements				Note: BABAR magnet acquired
Azimuthal coverage	360	deg	-	full 2π coverage
Tracker radius	≤80	cm	max	
Momentum resolution	1.2	%	nom	for p <sub>T</sub> in the range 4-10 GeV/c
Tracking resolution limit	40	GeV/c	min	$(dp/p < 0.2\% \times p)$
Electron identification efficiency	70	%	min	in Central Au+Au at for p <sub>T</sub> = 4 GeV/c
Read Out Speed	15	kHz	nom	р соли
Inner Re-Use PIXELS Option Mechanical	13	KIIZ	110111	
Acceptance angle	36.80	deg	nom	
Inner radius	6.60	cm	min	
Radial Thickness (at centerline)	TBD	cm	max	
Outer Radius	TBD	cm	max	
Weight Estimate	TBD	lb	-	Rough Engineering estimate based on similar equipment
Active area Length	TBD	cm	est	Calculated from acceptance
Electronics heat generation	TBD			·
Coolant	TBD			
Coolant Inlet temp	TBD			
Coolant inlet pressure	TBD			
Coolant Flow rate	TBD			
Coolant Pressure drop	TBD			
Inner Re-Use PIXELS Option Electrical				
				Existing from PHENIX VTX detector with reconfigured with spares
# of Layers	2	each	-	added to provide full coverage.
# of ladders layer 1	12			
# of ladders layer 2	24			
Pixels per ladder	50 x 425	μm x μm	-	A concors /Inddor v A POCs/sonson v 9103 nivel-/POC 434 073
Pixels per ladder # of channels	131072 TBD	pixels/lad	-	4 sensors/ladder x 4 ROCs/sensor x 8192 pixels/ROC =131,072
# OT Channels # LV Cables	TBD	1		
# LV Cables LV Cable size (dia)	TBD	+		
LV Cable Size (dia) LV Cable length	TBD			
# Signal cables	TBD	+		
Signal Cables Signal Cable size (dia)	TBD			
Signal Cable length	TBD	1		
Radiation length/ladder	1.28	%		
Inner new MAPS PIXELS Option Mechanical				
Acceptance angle	36.80	deg	nom	
Inner radius	TBD	cm	min	
Radial Thickness (at centerline)	TBD	cm	max	
Outer Radius	TBD	cm	max	
Weight Estimate	6350.00	lb	-	Rough Engineering estimate based on similar equipment
Active area Length	213.88	cm	est	Calculated from acceptance
Electronics heat generation	TBD	1		

Design value	l
calculated	l
	н

	calculated			
Parameter		Units	Tolerance	Notes
	<b>T</b> DD	0		110100
Coolant	TBD			
Coolant Inlet temp	TBD			
Coolant inlet pressure	TBD			
Coolant Flow rate	TBD			
Coolant Pressure drop	TBD			
coolaire ressure drop	100			
Inner new MAPS PIXELS Option Electrical				
				2 layers of existing pixels (or 3 layers new) 5 layers new silicon strip
# of Layers	3	each	_	sensors
# of ladders layer 1	TBD			
,				
# of ladders layer 2	TBD			
# of ladders layer 3	TBD			
Pixel size	30 x 30	μm x μm	-	
Pixels per ladder	TBD	pixels/lad	-	
# of channels	TBD	1		
# LV Cables	TBD			
		_		
LV Cable size (dia)	TBD			
LV Cable length	TBD			
# Signal cables	TBD			
Signal Cable size (dia)	TBD			
Signal Cable length	TBD	1		
Radiation length/ladder	0.30	%		
Nation length/lautei	0.30	/0		
Outer Silicon Strip Option Mechanical				
Acceptance angle	36.80	deg	nom	
Inner radius	TBD		min	
		cm		
Radial Thickness (at centerline)	TBD	cm	max	
Outer Radius	70.00	cm	max	
Weight Estimate	TBD	lb	-	Rough Engineering estimate based on similar equipment
Active area Length	104.80	cm	est	Calculated from acceptance at outer radius
Electronics heat generation	TBD			
	TBD	+		
Coolant		+		
Coolant Inlet temp	TBD			
Coolant inlet pressure	TBD			
Coolant Flow rate	TBD			
Coolant Pressure drop	TBD			
Р				
Outon Cilican Chris Ontion Flactrical		_		
Outer Silicon Strip Option Electrical				
				layers 3 thru 5 for detector reusing PHENIX pixels (layers 4 thru 6 for
# of Layers	3	each	_	MAPS)
# of ladders layer 3 (4 when MAPS is interior)	36	Cucii	_	
		+	-	
# of ladders layer 4 (5 when MAPS is interior)	44			
# of ladders layer 5 (6 when MAPS is interior)	48			
# of modules/ladder layer 3 (4)	3	-	-	ladders have 2 sublayers-> 2x3x36 = 216 sensors/ladder
# of modules/ladder layer 4 (5)	7			ladders have 2 sublayers-> 2x7x44 = 616 sensors/ladder
# of modules/ladder layer 5 (6)	14			ladders have 1 sublayer-> 1x14x48 = 672 sensors/ladder
# of modules/ladder layer 5 (0)	1 1	+		prototype 240 µm sensors are in production and may be used for
and the state of t	222	1		
sensor thickness	320	μm		layers 3 & 4 to minimize multiple scattering within sensor material
sensor length	96	mm		
sensor width (in azimuth)	92.16	mm		
# LV Cables	TBD			
LV Cable size (dia)	TBD	1		
LV Cable length	TBD	+		
	_	+		
# Signal cables	TBD			
Signal Cable size (dia)	TBD			
Signal Cable length	TBD			
total radiation length	4.2	%		% for layer 3, 1.2% for layer 4, 1% for layer 5
<u> </u>		1		
Outon TDC - which had been been				
Outer TPC option Mechanical				
Acceptance angle	36.80	deg	nom	
Inner radius	30.00	cm	min	
Radial Thickness (at centerline)	50.00	cm	max	
Outer Radius	80.00			
	ı 80.00	cm	max	I .
		_		Development of the section of the se
Weight Estimate Active area Length	TBD 160.00	lb	-	Rough Engineering estimate based on similar equipment  Calculated from acceptance

Design value calculated

	Units	Tolerance	Notes
12.00	mm^2		with 45 radial segments
TBD			
T2K or ALICE gas			Trdeoff study needed
247,400	each	-	
Quadruple GEM	1	-	(Same as ALICE upgrade design
2000			(Same as ALICE upgrade design
TBD			
32000	V	-	400 V/cm, conservatively high
	TBD TBD TBD TBD TBD TBD TBD TBD TCK or ALICE gas  247,400 Quadruple GEM 2000 TBD	12.00 mm^2 TBD TBD TBD TBD TBD TBD TBD TCK or ALICE gas  247,400 each Quadruple GEM - 2000 TBD	12.00 mm^2  TBD  TBD  TBD  TBD  TBD  TBD  TBD  TB

	Design value	1		
	calculated			
Parameter		Units	Tolerance	Notes
Elecro-Magnetic Calorineter				
EMCal PHYSICS Requirements				
Azimuthal coverage	360	deg	-	full 2π coverage
Pseudorapidity coverage, η (eta)	≤ 1.1	-	(range)	
EMCal inner radius	90	cm	min	
Energy Resolution	<=15%/sqrt(E) 0.024 x 0.024		2000	
EMCal segmentation Δη x Δφ EMCal cluster trigger	capable	-	nom -	in p+p and p+A at with rejections > 100 for E <sub>v</sub> > 10 GeV
Sampling Fraction	~2.3	%	nom	acceptable
radiation length	~7	mm	nom	acceptable
Moliere radius	~2.3	cm	nom	acceptable
Additional noted qualitative requirements	-	-	-	Fit inside sPHENIX Magnet
				High Segmentation for heavy ion collisions
				Occupy minimal radial space (short X <sub>0</sub> , small R <sub>M</sub> )
				Minimal cracks and dead regions
				zProjective (approximately)
				Readout works in a magnetic field
EMCal Mechanical				(See drawing SP00-000-004 for envelope design)
	tungsten powder &			
Absorber Material	Ероху	-	-	estimated density: 11.91 g/cu cm
Acceptance angle	36.80	deg	nom	
	00.00			Includes Light collection and readout; active detector begins at
Inner radius Radial Thickness (at centerline)	90.00	cm	min	radius = 97.5 cm Includes EMCal to Inner HCal support rails and caliration fiber(s)
Outer Radius	26.13 116.13	cm	max	Iniciddes Elvical to Inner Acai support rails and caliration liber(s)
Active area Thickness (AKA tower length)	144.00	cm cm	max max	
Absorber (active area) Length	299.00	cm	+/-0.5	
Weight Estimate	61000.00	Ib	max	~31 US ton estimate based on dimensional approximations
Readout clearance (at outer radius)	7.50	cm	max	ST CO CON COMMUNICACIONAL APPROXIMATIONS
# of Supermodules	64	-	-	
	THP Technon 100			>=99.9% W purity, <.01% impurities (Fe, Ni, O2, Co, Cr, Cu, Mo), bulk
Tungsten specification	mesh	-	-	density (solid) >=18.5 g/cm <sup>3</sup>
Tungsten Particle Size	<100	μm		, , , , , , , , , , , , , , , , , , , ,
Tungsten powder density	>=11.25	g/cm <sup>3</sup>		
nominal density of W/SciFi/Epoxy bricks	10	g/cm <sup>3</sup>	nom	
Electronics heat generation	6.45	kW	est	estimated 262.6 mW/channel * 24576 Channels
Coolant	TBD	-	-	
Coolant Inlet temp	TBD	-	-	
Coolant inlet pressure	TBD	-	-	
Coolant Flow rate	TBD	-	-	
Coolant Pressure drop	TBD	-	-	
5040 11: 11:0 11:1:				
EMCal Light Collection		ı	I	Included that the American shall the shift had a Toronton
# of towers (1 tower nor shannel)	24576			96 longitudinally (in z) x 256 azimuthally (in phi) basic Tungsten-
# of towers (1 tower per channel) # of SciFi blocks (4 towers per block)	24576 6144	-	-	Scintilating fiber-Epoxy (W/SciFi) unit of fabrication
# OF SCIFF BIOCKS (4 LOWERS PER BIOCK)	0144	-	-	96 longitudinally (in z) x 256 azimuthally (in phi) basic Tungsten-
# of modules (2 x8 towers per module)	4	_	_	Scintilating fiber-Epoxy (W/SciFi) unit of fabrication
# of modules/sector	24	-	-	384/16 = 384
# towers/sector	384	-	-	
# of SiPM's	98304	-	-	4 SiPMs per tower
# of Sectors	64	-	-	2 longitudinally 32 azimuthally
fiber material	Kuraray SCSF78	-	-	(blue)
cladding	single			
core material	polystyrene			
	polymethyl-			
cladding material	methacrylate			
emmission peak	450.00	nm	spec	
decay time	2.80	ns	spec	
attenuation length	>=4.0	m		
embedded fiber diameter	0.47	mm	nom	As the condition of the
anala adda d filoso a contra	4.00			At inner radial end of towers, grows along fiber length from inner
embedded fiber spacing	1.00	mm	nom	radius to outer radius in proportion to tower dimension taper
Epoxy spec pot life	Epo-Tek 301 1.50	hr	±/_E	
index of refraction	1.50	-	+/5	at 589 nm
mack of remaction	1.34			Jul 202 mm

	Design value calculated			
Parameter		Units	Tolerance	Notes
spectral transmission	>= 99	%		at 382-980 nm
		_		1 light guide per tower tower output end dimensions 19.8 mm x 19.8
Light guide base area	392.00	mm <sup>2</sup>		mm
Light guide SiPM active area	36.00	mm²		4 SiPM per guide 3 mm x 3mm per SiPM
Light guide to SiPM coupling efficiency	71.00	%		As measured in prototypes using silicone cookies
				Note: SiPM's to be gain matched and share common bias voltage for
				each 4 SiPM set per guide
EMCal Electronics				
# of channels (1 preamp per channel)	24576	Τ.	T -	
# of modules	3072	-	_	8 blocks per module blocks are common sized
				48 modules per supermodule 2 supermodules in length x 32
# of supermodules	64	-	-	modules in circumference
# LV Cables	64	-	-	
LV Cable size (dia)	0.25	in	nom	
LV Cable length	10	m	nom	
# Signal cables	3072	-	-	
Signal Cable size (dia)	0.25	in	nom	
Signal Cable length	10	m	nom	
# Comm cables	64	-	-	
Comm Cable size (dia)	0.25	in	nom	
Comm Cable length	10	m	nom	
# Bias cables	3072	-	-	
Bias Cable size (dia)	0.20	in	nom	
Bias Cable length	10	m	nom	
Outer Hadronic Calorineter				
Outer HCal PHYSICS Requirements				
Azimuthal coverage	360	deg	-	full 2π coverage
Pseudorapidity coverage, η (eta)	≤ 1.1	-	(range)	
Outer HCal inner radius	182	cm	min	envelope; active area is further out
Radial thickness	87	cm	max	envelope; active area is smaller
				Innner + Outer HCal Energy resolution requirement $\sigma/E = 100\%/VE$
Energy absorbed	>95	%		in heavy ion collisions
HCal segmentation Δη x Δφ	~0.1 x 0.1	-	nom	
Light collection per fiber	~80	%		
Total towers (η x φ)	24 x 64	-	-	1536 total (tower = electronic signal channel)
nuclear interaction length	6		nom	total Inner + Outer HCals
number of gap crossings by a radial particle Tower size ( $\eta \times \varphi$ ) (approximate)	15 x 13	-	min	to minimize channeling
Sampling fraction at inner radius	0.037	cm		
Sampling fraction at inner radius	0.037	-	-	
Sampling fraction at outer radius	0.028		_	
Outer HCal Mechanical				
Absorber Material	1005 1 1			
	1006 steel	-	-	High magnetic permeability steel (min rel perm =100)
Acceptance angle	36.8	- deg	- nom	High magnetic permeability steel (min rel perm =100) (angle with respect to beam orbit; equal to $\eta$ =1.1)
Acceptance angle Stay clear radial clearance between cryostat and		- deg	- nom	
•		deg cm	nom min	
Stay clear radial clearance between cryostat and	36.8			(angle with respect to beam orbit; equal to $\eta$ =1.1)
Stay clear radial clearance between cryostat and Outer HCal	36.8 4.0	cm	min	(angle with respect to beam orbit; equal to $\eta$ =1.1)  Outer Hcal combs must be outside of this clearance
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline)	36.8 4.0 182.0 183.0 80.5	cm cm	min min	(angle with respect to beam orbit; equal to $\eta$ =1.1)  Outer Hcal combs must be outside of this clearance
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area)	36.8 4.0 182.0 183.0	cm cm cm	min min min	(angle with respect to beam orbit; equal to $\eta$ =1.1)  Outer Hcal combs must be outside of this clearance
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area)	36.8 4.0 182.0 183.0 80.5 5.0 263.5	cm cm cm	min min min nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope)	36.8 4.0 182.0 183.0 80.5 5.0 263.5 268.5	cm cm cm cm	min min min nom nom nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length	36.8 4.0 182.0 183.0 80.5 5.0 263.5 268.5 610.0	cm cm cm cm cm cm	min min min nom nom nom max +1/-0	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length	36.8 4.0 182.0 183.0 80.5 5.0 263.5 268.5 610.0 722.0	cm cm cm cm cm cm cm	min min min nom nom nom +1/-0 +1/-0	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance  Includes end caps
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate	36.8 4.0 182.0 183.0 80.5 5.0 263.5 268.5 610.0 722.0 854000	cm cm cm cm cm cm cm cm	min min min nom nom nom +1/-0 est	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance Includes end caps  427 US ton Estimate based on dimensional approximations
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module	36.8 4.0 182.0 183.0 80.5 5.0 263.5 268.5 610.0 722.0	cm cm cm cm cm cm cm	min min min nom nom nom +1/-0 +1/-0	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance  Includes end caps
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module Stay clear clearance (beyond envelope outer	36.8  4.0  182.0  183.0  80.5  5.0  263.5  268.5  610.0  722.0  854000  26688	cm cm cm cm cm cm cm cm cm lb	min min min nom nom nom max +1/-0 +1/-0 est est	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance Includes end caps  427 US ton Estimate based on dimensional approximations
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module Stay clear clearance (beyond envelope outer radius)	36.8  4.0  182.0  183.0  80.5  5.0  263.5  268.5  610.0  722.0  854000  26688	cm cm cm cm cm cm cm cm cm lb	min min min nom nom nom max +1/-0 +1/-0 est est nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance Includes end caps  427 US ton Estimate based on dimensional approximations
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module Stay clear clearance (beyond envelope outer radius) # of Absorber Plates	36.8  4.0  182.0  183.0  80.5  5.0  263.5  268.5  610.0  722.0  854000  26688  7.5  320	cm cm cm cm cm cm cm cm cm cm	min min min nom nom nom max +1/-0 +1/-0 est est nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance  Includes end caps  427 US ton Estimate based on dimensional approximations
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module Stay clear clearance (beyond envelope outer radius) # of Absorber Plates Absorber plate thickness at inner radius	36.8  4.0  182.0  183.0  80.5  5.0  263.5  268.5  610.0  722.0  854000  26688  7.5  320  26.10	cm cm cm cm cm cm cm cm cm cm cm	min min min nom nom nom max +1/-0 +1/-0 est est nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance  Includes end caps  427 US ton Estimate based on dimensional approximations
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module Stay clear clearance (beyond envelope outer radius) # of Absorber Plates	36.8  4.0  182.0  183.0  80.5  5.0  263.5  268.5  610.0  722.0  854000  26688  7.5  320	cm cm cm cm cm cm cm cm cm cm	min min min nom nom nom max +1/-0 +1/-0 est est nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance  Includes end caps  427 US ton Estimate based on dimensional approximations  =1/32 of estimated total weight (13.34 US tons each)
Stay clear radial clearance between cryostat and Outer HCal Inner radius (envelope) Inner radius (active area) Radial Thickness (active area at centerline) Clearance for outer electronics Outer Radius (active area) Outer Radius (envelope) Absorber (active area) Length Absorber (envelope) Length Weight Estimate Weight per module Stay clear clearance (beyond envelope outer radius) # of Absorber Plates Absorber plate thickness at inner radius	36.8  4.0  182.0  183.0  80.5  5.0  263.5  268.5  610.0  722.0  854000  26688  7.5  320  26.10	cm cm cm cm cm cm cm cm cm cm cm	min min min nom nom nom max +1/-0 +1/-0 est est nom	(angle with respect to beam orbit; equal to η =1.1)  Outer Hcal combs must be outside of this clearance  Calculated from Magnet outer dim + 4 cm clearance  Calculated (inner + thickness)  Calculated from acceptance  Includes end caps  427 US ton Estimate based on dimensional approximations

Design value	
calculated	
	_

	calculated		<b>T</b> 1	N. i
Parameter		Units	Tolerance	Notes
Coolant	Ambient air			
Coolant Inlet temp	50.00	F	nom	(HVAC design requirement)
Coolant inlet pressure	n/a	-	1	Heat removal to be by natural convection
Coolant Flow rate	n/a	-	-	
Coolant Pressure drop	n/a	-	-	
Outer HCal Light Collection				
tile gap	8.50	mm	+/5	
tile thickness	7.00	mm	+/5	
				calculated for min 4 gap crossings by any radial line, at radial
tile inclination	12	deg	-	crossing of tile centerline ("tilt angle")
# of gaps	320	-	-	same as # of tiles and # of absorbers
# of tiles per gap	24	-	-	
# of SiPM's	7680	-	-	one per tile
	doped/extruded			·
Tile material	polystyrene	-	-	
	1.5, 0.01,			
Scintillation dopant: PTP & POPOP	respectively	%	nom	
Tile reflective coating	(proprietary)	-	-	by surface exposure to aromatic solvents (UNIPLAST)
Tile wrapping thickness: Aluminum foil/cling	(11	mm/µm/		
wrap/black TEDLAR	0.1/30/100	μm	nom	
Tile wrapping thickness	0.23	mm	+/1	Total
Tile attenuation length	30.00	mm	nom	perpendicular to extrusion direction
embedded fiber material	Kuraray Y11	-	-	wavelength shifting fiber: Formulation: 200, K-27, S-type, single clad
embedded fiber diameter	1.00	mm	nom	round
Fiber numerical aperature (NA)	0.55	-	-	
Fiber emmission angle	33.70	deg	nom	
Fiber trapping efficiency	3.10	%	nom	
Fiber core material	polystyrene	-	-	
Fiber core attenuation length	>2	m	_	
Fiber core density	1.05	g/cc	nom	
Fiber core refractive index	1.49	-	nom	
Fiber cladding thickness	0.02	mm	nom	
Fiber cladding material	PMMA	-	-	polymethylmethacrylate
Fiber cladding density	1.19	g/cc	nom	
Fiber cladding refractive index	1.49	-	nom	
Fiber color	green	-	-	
Fiber emmission peak	476.00	nm	nom	
Fiber absorption peak	430.00	nm	-	
Fiber attenuation length	3.50	m	minimum	
Minimu fiber bending radius	100.00	mm	minimum	
Optical cement	Epotek 3015	-	-	
apara comen	Epotek 3013			
Outer HCal Electronics				
# of channels (1 preamp per channel)	1536	I -	-	(5 SiPM's per channel)
# Of Charmers (1 preamp per Charmer)	1330	_	<u>-</u>	(2 sirivi s per cridiffier)